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Canada - Alberta - Northwest Territories
~~Boundary Commission~~
Commissioners
~~Boundary Commission~~

R. Thistlethwaite, D.L.S., A.L.S., B.C.L.S.,
Surveyor General, for the Government of Canada

J. H. Holloway, D.L.S., A.L.S.,
Commissioner, for the Government of Alberta

Report of the Commissioners
Appointed to Direct the Survey and
Demarcation of the Boundary
between the Province of Alberta and
The Northwest Territories.

Alberta-Northwest Territories Boundary
Commission
1956



EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1956

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OTTAWA, ONTARIO,
SEPTEMBER 1, 1956.

TO THE HONOURABLE GEORGE PRUDHAM, M.P., MINISTER OF MINES AND TECHNICAL SURVEYS, OTTAWA, CANADA; THE HONOURABLE N. A. WILLMORE, M.L., MINISTER OF LANDS AND FORESTS, EDMONTON, ALBERTA.

Your Commissioners, R. Thistlethwaite, D.L.S., A.L.S., B.C.L.S., representing the Government of Canada, and J. H. Holloway, D.L.S., A.L.S., representing the Government of Alberta, have the honour to make the following report on the survey of the Alberta-Northwest Territories boundary performed during 1924, 1925, and 1950 to 1954 inclusive.

The survey field work was done by the following surveyors under instructions of the Surveyor General for Dominion Lands with respect to the work done in 1924 to 1925 and under instructions of your Commissioners with respect to the work done from 1950 to 1954:

Control:

H. Parry, D.T.S., 1924.
W. D. Forrester, B.A., 1950, 1951 and 1952.

Demarcation:

R. W. Cautley, D.L.S., A.L.S., 1925.
C. B. C. Donnelly, D.L.S., A.L.S., 1950, 1951, 1952, 1953 and 1954.
G. Palsen, D.L.S., A.L.S., 1953.

Accompanying this report is an atlas of 20 maps, covering the boundary from the northeast to the northwest corners of Alberta.

(Signed) R. THISTLETHWAITE }
J. H. HOLLOWAY } *Commissioners.*

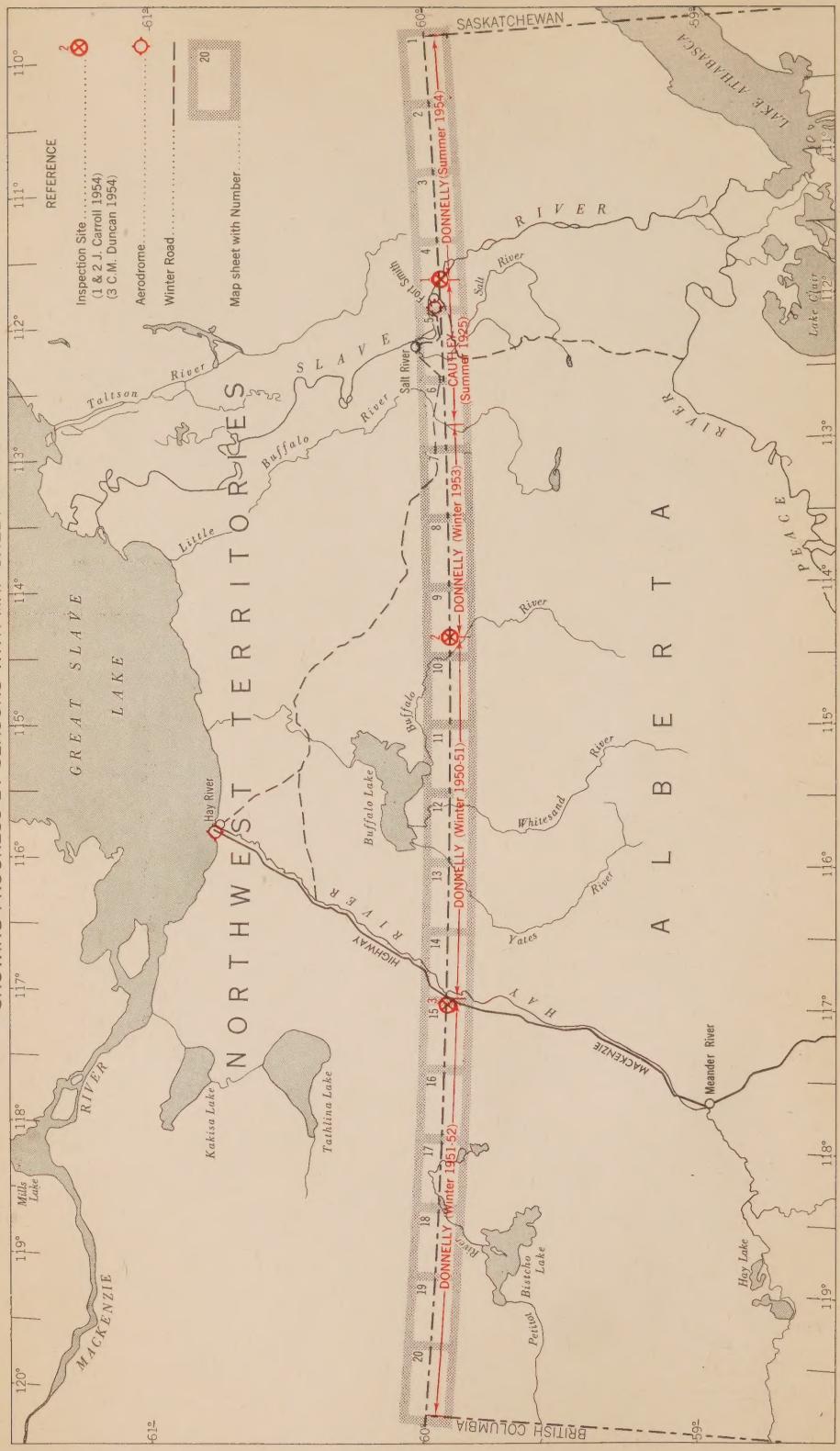


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KEY MAP

SHOWING PROGRESS BY SEASONS WITH MAP SHEET INDEX



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CHAPTER I

INTRODUCTION

This report of the Alberta-Northwest Territories Boundary Commission includes not only surveys made under the direction of the Commission but also the earlier work done by the Department of the Interior in 1924 and 1925. In those years, 36 miles of the boundary were surveyed from Slave River to Little Buffalo River.

The Commission was established by Provincial and Federal Orders in 1949 and 1950 to carry out the survey of the remaining 310 miles of the boundary. Work began immediately and was completed in the summer of 1954.

The various principal Acts and Orders connected with the boundary and establishment of the Commission are described below.

The Alberta Act, assented to July 20, 1905, 4 and 5 Edward VII Chapter 3, defines the Province of Alberta as follows:

"2. The territory comprised within the following boundaries, that is to say,—commencing at the intersection of the international boundary dividing Canada from the United States of America by the fourth meridian in the system of Dominion lands surveys; thence westerly along the said international boundary to the eastern boundary of the province of British Columbia; thence northerly along the said eastern boundary of the province of British Columbia to the northeast corner of the said province, thence easterly along the parallel of the sixtieth degree of north latitude to the fourth meridian in the system of Dominion lands surveys as the same may be hereafter defined in accordance with the said system; thence southerly along the said fourth meridian to the point of commencement — is hereby established as a province of the Dominion of Canada, to be called and known as the province of Alberta."

The District of Mackenzie, Northwest Territories, is described in P.C. Number 655, March 16, 1918, as being bounded on the south by the parallel of the sixtieth degree of north latitude.

Prior to 1930 the public lands on both sides of the Alberta-Northwest Territories boundary were Dominion Lands and were under the jurisdiction of the Federal Government. For the purposes of administering game, timber and mining regulations and of granting patents to surveyed lands in proximity to the boundary, the survey of a portion of it in the vicinity of Slave River was required by the

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former Department of the Interior as early as 1921. The Government of the Province of Alberta was not interested in it at the time, but although it would not share the cost, it agreed to accept a survey made by the Department as the final survey and to proceed with the necessary confirming provincial legislation when the work was completed.

In accordance with this agreement, the survey of the boundary between Slave and Little Buffalo Rivers was made under the direction of the Surveyor General of Dominion Lands in 1924 and 1925.

With the transfer of the natural resources to the province in 1930, the boundary became the equal concern of the Federal and Provincial Governments. In 1949 prospecting for petroleum in its vicinity gave urgency to its immediate survey in order to define jurisdictional areas. The survey was also required to provide ground control for the large aerial mapping programs being undertaken by both governments. It was therefore mutually agreed that a boundary commission should be established to undertake the survey and demarcation of the boundary line, the costs to be shared equally. This was done by Privy Council Order Number 692 of 14th February, 1950, and Provincial Order in Council Number 1393 of 21st November, 1949, the texts of which follow.

Copy of a Minute of a Meeting of the Committee of the Privy Council,
approved by His Excellency the Governor General on the 14th February,
1950,

P.C. 692

The Committee of the Privy Council have had before them a report dated 9th February, 1950, from the Minister of Mines and Technical Surveys, representing :

That the major portion of the boundary line between the Province of Alberta and the Northwest Territories defined as "the parallel of the sixtieth degree of north latitude" by the Alberta Act, Chapter 3, 4-5, Edward VII, has not been surveyed and marked on the ground.

That it is desirable that the survey and demarcation of this boundary line be completed as soon as possible in order to provide control points for aerial photographic mapping and to define the limits of Federal and Provincial jurisdiction for administrative purposes;

That the Province of Alberta has agreed to the establishment of a Boundary Commission consisting of the Surveyor General of Dominion Lands representing Canada, and the Director of Surveys, Department of Public Works for the Province of Alberta, representing the Province, and that the said Province also indicated its willingness to share equally in the expenses of the said boundary survey.

The Committee, therefore, on the recommendation of the Minister of Mines and Technical Surveys, advise that authority be granted to establish a Commission to be known as the Alberta-Northwest Territories Boundary Commission consisting of Bruce Wallace Waugh, Surveyor General of Dominion Lands, who shall be Chairman, and John Hubert Holloway, Director of Surveys, Department of Public Works of the Province of Alberta, with authority to issue instructions for and direct the execution of all necessary surveys including the employment of personnel and purchase of equipment and supplies required to undertake the survey of the boundary line between the Province of Alberta and the Northwest Territories, and to accept in their discretion previous fixations of boundary points where these points are of the desired accuracy, Canada to pay one-half the cost incurred by this Commission to be chargeable against Legal Surveys and Geodetic Survey of Canada appropriations.

The Committee further advise that the report on the said surveys be submitted by the said Alberta-Northwest Territories Boundary Commission to the Parliament of Canada and the Government of the Province of Alberta.

(Signed) N. A. ROBERTSON
Clerk of the Privy Council.

The Honourable
The Minister of Mines and Technical Surveys.

Copy of an Order of the Lieutenant Governor in Council of the Province of Alberta, dated Monday, November 21st, 1949.

O.C. 1393/49

Approved and ordered,

(Signed) J. C. BOWEN
Lieutenant Governor

Edmonton, Monday, November 21st, 1949.

The Executive Council has had under consideration the report of the Honourable the Minister of Public Works, dated November 18th, 1949, stating that:

WHEREAS the major portion of the boundary line between the Province of Alberta and the Northwest Territories has not been surveyed and marked on the ground; and

WHEREAS it is desirable that the survey and demarcation of the said boundary line be completed as soon as possible in order to provide control points for aerial photographic mapping and to define the limits of provincial jurisdiction with respect to petroleum and natural gas development in the northerly part of the Province; and

WHEREAS it has been proposed by the Surveyor General for the Dominion of Canada that an Alberta-Northwest Territories Boundary Commission be established to take charge of the survey of the said boundary and that the costs of such survey be shared equally by the Province and the Dominion;

THEREFORE, upon the recommendation of the Honourable the Minister of Public Works, the Executive Council advises:

1. THAT the Government of Alberta agrees to participate in completing the survey and demarcation of the said boundary line and to pay one-half of the costs of such survey;
2. THAT JOHN HUBERT HOLLOWAY, Director of Surveys, Department of Public Works, be and he is hereby appointed as Boundary Commissioner to represent the Province on an Alberta-Northwest Territories Boundary Commission.

(Signed) ERNEST C. MANNING
Chairman

On the retirement of B. W. Waugh, Surveyor General of Canada, his successor in that office, Robert Thistlethwaite, was appointed Chairman of the Commission by P.C. 1954-706, the text of which follows.

P.C. 1954-706

Privy Council
Canada

AT THE GOVERNMENT HOUSE AT OTTAWA
THURSDAY, the 13th day of May, 1954.

PRESENT:

HIS EXCELLENCY

THE GOVERNOR GENERAL IN COUNCIL:

His Excellency the Governor General in Council, on the recommendation of the Minister of Mines and Technical Surveys, is pleased to appoint and doth hereby appoint Robert Thistlethwaite, Esquire, Surveyor General of Canada to be a member of each of the following Commissions, vice Bruce Wallace Waugh who has retired from the Public Service:

British Columbia-Yukon-Northwest Territories Boundary Commission, established by Order in Council P.C. 5355 of 5th July, 1943, as amended;

Alberta-Northwest Territories Boundary Commission, established by Order in Council P.C. 692 of 14th February, 1950;

Saskatchewan-Northwest Territories Boundary Commission, established by Order in Council P.C. 3801 of 21st August, 1952.

"R. B. BRYCE"
Clerk of the Privy Council.

CHAPTER II

DEPARTMENT OF INTERIOR SURVEY, 1924 and 1925

For reasons already stated and on the urgent request of the Northwest Territories and Yukon Branch of the Department of the Interior, the Topographical Surveys Branch of that Department undertook the survey of a part of the boundary adjacent to Slave River in 1924 and 1925. The government of the Province of Alberta co-operated to the extent of agreeing to accept the line surveyed as a part of the boundary and to seek confirming legislation.

Three astronomic observations to establish the position of the 60th parallel were carried out by Mr. H. Parry, D.T.S., in 1924. The following year, Mr. R. W. Cautley, D.L.S., A.L.S., surveyed approximately 36 miles of the line.

Instructions Issued to Surveyors

Instructions issued to H. Parry, D.T.S., by the Surveyor General of Dominion Lands on May 31, 1924, are summarized as follows:

The portion of this boundary for which a survey is most urgently required is that westward from Slave River to Little Buffalo River, and eastward to the 4th meridian, the east boundary of Alberta.

Before the survey can be made it is necessary to establish the position of the 60th parallel at a number of points by prime latitude observations. You are to make some of the required observations during the present year.

It is desirable that the observation stations be about 10 or 12 miles apart in longitude and at no greater distance than 20 chains from the parallel. At each station a sufficient number of stars should be observed to ensure a prime definition of the parallel. The probable error should not exceed 10 feet.

Each observation station should be carefully marked on the ground so that it may be readily located by the survey party. A line should be blazed from the station to the parallel and the position of the station referenced either by earth or stone mound, by bearing trees or otherwise.

Instructions issued to R. W. Cautley, D.L.S., A.L.S., by the Surveyor General of Dominion Lands on April 25 and May 1, 1925, are summarized as follows:

The line to be surveyed is the boundary between Alberta and the Northwest Territories which is the astronomical 60th parallel of north latitude. It is to be surveyed between the west bank of Slave River and Little Buffalo River, a distance of about 34 miles.

Control: By precise astronomical latitude observations made with the zenith telescope, the position of the 60th parallel of north latitude was established in 1910 at a point on the west

bank of Slave River by Carl Engler, D.L.S. The point is marked with a wooden post, an iron post and a trench.

Also, at approximate distances of 11, 19 and 34 miles west of Slave River, three precise latitude observations in the proximity of the 60th parallel were made by H. Parry, D.T.S., in 1924. A monument is to be erected on the parallel opposite each of the three observation stations, providing the ground is suitable. In any event the monument should not be more than one-quarter mile to the east or west of the observation station.

Method of Survey: The boundary is then to be located and monumented between the control points thus established. The method recommended is to accurately survey a trial line tangent to the parallel at one of the control points and measure the meridional distance from it to the succeeding control point. Calculation may then be made of the meridional offset from any point on the trial line to a point on the parallel as defined by the two control points.

Azimuths and Distances: The production of the transit lines and the astronomical observations for azimuth are to be made according to the methods in use on the survey of base lines and meridians in the Dominion Lands Survey systems, using a 6-inch reiterating micrometer transit. Distance measurements are to be to the same standard of accuracy as those observed in the survey of governing lines.

Monuments: The boundary is to be monumented at intervals not exceeding 120 chains and at all intersections with rivers, waterways or trails. Wherever possible, consecutive monuments should be intervisible. Each monument is to consist of a standard post, a mound, and two pits. The post caps are to be stamped with the monument number, N.W.T. to the north of the centre line, ALBERTA to the south, and the year of erection. Posts at control points are to have the additional inscription AST.

The monument at the control point on the west bank of Slave River is to be replaced with a concrete monument sunk 3 feet into the ground and being 2 feet square below the surface. Above the ground surface the monument is to be one-foot high and of pyramidal form one-foot square at the top. The properly inscribed post is to be embedded in its centre. This monument is to be numbered one and successive monuments to the west are to be numbered 3, 5, 7, etc.

Spirit Levels: Spirit levels are to be run in accordance with Chapter VII of the Manual of Instructions for the Survey of Dominion Lands. They are to be commenced by connecting with at least two of the bench marks established in the 1921 traverse of Slave River between Fitzgerald and Fort Smith.

It will not be necessary to plant bench marks; the tops of monument posts may be used for this purpose.

Magnetic Declination: Observations for the magnetic declination are to be made in accordance with Chapter 2 of the Supplement to the Manual of Instructions for the Survey of Dominion Lands at intervals of about 2 miles.

Returns: The returns of the survey are to consist of a plan, field notes and computation, azimuth observations, observations for magnetic declination, level notes and a general report.

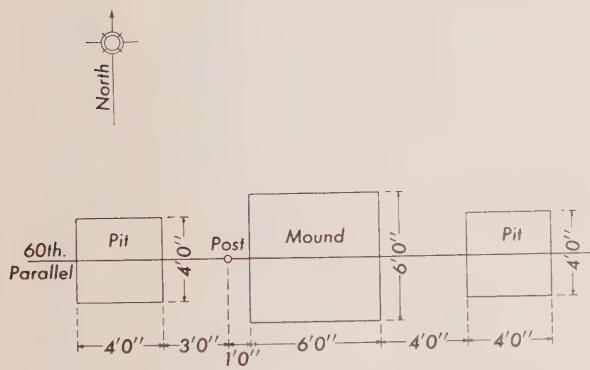
Smith Settlement: The south boundary of lots 8, 9, 10 and 11 is erroneously shown on a printed plan of Smith Settlement as the boundary between Alberta and the Northwest Territories. In order to avoid confusion temporary monuments only are to be established along the boundary adjacent to these lots at this time. The marking of the lot boundary posts and the bearing of the south boundary of the lots are to be carefully noted.

Field Operations

In the 1924 season, Mr. Parry established control at three points on the 60th parallel west of Slave River, but was unable to proceed east of the river because of illness. The results of his observations are shown in Table I.

In the following season, Mr. Cautley organized his party, consisting of G. Palsen, D.L.S., as assistant, and ten men, at Edmonton and proceeded to Fort Smith. The survey of the boundary was commenced at Monument No. 1 on the west bank of Slave River on May 26 and was completed, according to instructions, to Monument No. 65 at Little Buffalo River on August 7, 1925. The length of boundary surveyed was nearly 36 miles.

Monument No. 1 was replaced by a concrete pier at the exact point occupied by the original monument and No. 5, 7, 9, etc., to 65 were erected on the boundary. Monument No. 65 is about 8 chains beyond the westerly latitude observation station. Adjacent monuments are intervisible.



**Arrangement of monument components and typical marking
of D.L.S. standard post cap, 1925.**

As the site for Monument No. 3 fell to the north of the south boundary of lots 8, 9, 10 and 11 of Smith Settlement, the instruction to erect temporary monuments only in this area was effectively dealt with by planting a properly inscribed post 3 inches under the ground surface in its correct location on the boundary. No mound or pits were made at the point. The monument site was witnessed by a wooden post, inscribed X, planted 10 links to the west.



Wooden post witnessing Monument No. 3. The fence is along the 1925 south boundary of lots 8, 9, 10 and 11, Smith Settlement.

The funds available for the survey were not sufficient to permit the correction of small errors in the location of Monuments No. 37 to 63 inclusive. In consequence the boundary is displaced to the south by distances varying from zero to a maximum of about 10 links (nearly 7 feet) over this section of nearly 17 miles. In terms of area, the circumstance favours the Northwest Territories by approximately 7 acres. The errors were caused through inability of the surveyor to obtain star observations during a lengthy period of cloudy weather at a critical time in the survey.

Differential spirit levels were run and verified over the whole of the line surveyed. They were based on an approximate datum obtained by estimating the fall of Slave River from its elevation determined at the 30th base line about 60 miles to the south. The adjustment required to reduce the elevations to mean sea level has since been determined.

The number of each monument, its nature or type, the distance and azimuth westerly to the next monument, and its elevation referred to mean sea level are given in Table II.

Wagon transport was used for the easterly 18 miles of the survey. For the remaining 17 miles, camp equipment and supplies were transported by man packing. Water, which was scarce and of poor quality, had to be brought to camp sites in the same manner. It is reported that the flies were extraordinarily troublesome.

CHAPTER III

PRESCRIBED METHODS OF SURVEY UNDER THE BOUNDARY COMMISSION

The methods of survey adopted by the Commission differed in certain details from those used by the Department of Interior in the 1925 survey. The general method of laying out the parallel, however, was the same, and followed the precedents established when the International Boundary and parts of the British Columbia-Yukon boundary were surveyed. The basic principles involved are outlined briefly in the following paragraphs.

There are two accepted methods of determining the latitude of a given point on the earth:

1. It may be deduced from star observations.
2. It may be deduced from linear measurement along the earth's surface from another point of which the latitude is known.

The astronomic method has the advantage of being independent of other surveys. It is therefore the obvious choice in remote territories where accurate linear surveys do not exist. By reason of its independent nature it also offers a desirable degree of flexibility.

In theory, the 60th parallel of astronomic latitude can be found and marked on the ground only by making the appropriate astronomic observation at or near each desired site for marking. To be useful, the parallel would need to be marked at intervals of about one or two miles.

Individual precise astronomic observations are expensive when compared with linear surveys extending a limited number of miles on the ground. Therefore, the economical expedient is to determine the ground position of the parallel at intervals of, say, 20 to 30 miles. In between, the boundary is laid out and monumented by means of ground survey between the astronomically fixed points, or "astrofixes". This is a means of striking a practical balance between strict theory and economy.

This method was followed when the International Boundary was surveyed. Following that precedent, the method was used to survey portions of the British Columbia-Yukon boundary and that portion of the Alberta-Northwest Territories boundary which was surveyed by the Department of the Interior in 1925. It was logical, therefore, to continue its use in the more recent surveys.

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Accordingly, the parallel has been marked by astronomic means at intervals averaging 22 miles. In between, the astronomic parallel has been approximated by a curved line which is everywhere equally inclined to the astronomic meridian. The intermediate monuments, at average intervals of 1½ miles, have been placed either on this curved approximation to the parallel or on short chords to it.

Between adjacent monuments, the boundary is taken to be the straight line joining them. This follows the principle established by the 1925 Treaty between the United States and Canada, regarding the International Boundary.

In the survey of the 36 miles of the boundary west of Slave River, as described in Chapter II, all monuments were placed at intervisible points on the approximated parallel as it was defined by the respective astronomic latitude observations. The boundary, by this survey, is therefore a succession of short chords to the approximated parallel. The chords are less than 120 chains in length.

In order to simplify the survey and subsequent maintenance of the boundary, the Commission decided that the remaining 310 miles should be surveyed in a manner similar to the base lines in the Dominion Lands Survey system. The chords to the parallel would then be 486 chains in length, except for one shorter chord at each controlling latitude observation station. By this method the monuments on each 486-chain chord are on a straight line and the number of deflection points in the boundary is considerably reduced compared with the earlier method. In consequence, use of the survey as control for subsidiary surveys will be simplified and replacement of any monument that may be destroyed will not be so difficult.

Previous Surveys Accepted

In accordance with the 1924 aforementioned agreement made between the Province of Alberta and the Department of the Interior, the Commission agreed to accept the 1924-25 survey of the 36 miles of the boundary west of Slave River, that is, between Monuments No. 1 and 65. It was decided that this portion of the boundary should be inspected on the ground, and that monuments should be restored where necessary and altered by the addition of two pits, one directly north and one directly south of each boundary post. Inspection on the ground showed that the 1925 monuments were easily found and that this alteration was not essential for the time being.

It was also agreed to accept Monument No. 39, established by the Saskatchewan-Alberta Boundary Commission in 1938 to mark the northern terminus of the Saskatchewan-Alberta boundary, as the northeast corner of the Province of Alberta.

Control for New Surveys

The Geodetic Survey of Canada was requested to make precise latitude observations to control the location of the boundary, subject to the following specifications:

Talcott's Method: The astronomical observations are to be made by Talcott's Method on not less than 40 pairs of stars observed over two or more nights, each observation to have a probable error not exceeding 0.10 seconds of arc (about 10 feet).

Selection of Points: Each observation point should be selected as closely as possible to the 60th parallel and should not be more than 20 chains from it except under very adverse conditions. To facilitate further survey operations, points should not be adjacent to abrupt rises in the ground immediately to the north or to the south. Observation points should be spaced at intervals of about 24 miles and in no case spaced farther apart than 40 miles.

The observation station adjacent to the intersection of the Alberta-British Columbia boundary with the 60th parallel should not be more than 20 chains from it in either latitude or longitude.

Marking of Points: The observation stations may be marked by $\frac{3}{4}$ -inch old-style section-corner posts marked LAT. I, LAT. II, etc., with a cold chisel and driven so that 6 inches of the posts remain above ground. The posts should be completely covered by circular mounds, 6 feet in diameter, the mounds being surrounded by trenches 18 inches wide and 12 inches deep. The points marked may be offset from the actual points of observation, the azimuth and length of the offset being measured and recorded.

A photograph of each observation point is desirable. In addition, its position should be pin-pointed on a vertical air photograph and a description entered on the back thereof.

Longitude Observations: Since the observation points are also to be used to control topographic mapping from vertical air photographs, longitudes to an accuracy of about 1 second of arc (50 feet) should be observed at each point.

Continuity of Observations: It is desired that the observations be made in continuity westward from Little Buffalo River.

Returns: The survey returns required are:

1. Diary.
2. Field observation records.
3. Computations giving resulting latitudes and longitudes and their probable errors, obtained by accepted methods used on precise work of this nature.
4. Plan of the locality of each observation station showing the position of the observation point, monument, bearing trees, etc., all distances and azimuths pertinent thereto, and any other information that will assist in finding and identifying the point.
5. Copies of air photographs with the observation points pin-pointed and identified thereon.
6. A general report of the nature of the country dealing particularly with the areas through which the 60th parallel will pass. The report should contain any information that will be of assistance in the final survey of the boundary line.

*General Summary of Instructions for the Survey
and Monumentation of the Boundary*

For the survey and monumentation of the boundary, the following instructions were issued by the Commission:

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Control: The Geodetic Survey of Canada has been requested to make precise latitude observations at intervals of about 24 miles within 20 chains of the boundary over its entire unsurveyed portions.

Method of Survey: The method of surveying and establishing the boundary shall be to erect permanent monuments on the boundary at suitable points close to two successive latitude observation stations; then join the two monuments by surveying a succession of 486-chain trial chords computed to place the terminal points of each chord on the 60th parallel as defined by the starting monument of the trial line. Then join the two monuments with a final line by surveying a succession of chords and a closing chord, computed from the trial line to place the terminal points of each chord on the 60th parallel as defined by the two monuments.

The boundary shall be the straight lines joining successive permanent boundary monuments.

Azimuths: The azimuths shall be obtained by precise astronomical observations on Polaris as directed for Governing Surveys in the Supplement to the Manual for the Survey of Canada Lands. At least one set, preferably of a minimum of three observations, should be made on each 486-chain chord. The azimuth of the boundary should be kept theoretic within a tolerance of about 6 seconds of arc.

Chainage: The boundary shall be measured by two independent accurate measurements, one in chains and the other in feet. The mean of the two measurements stated in chains is to be accepted. The discrepancy between them should not exceed 0.4 foot per mile. Account is to be taken of slope, temperature, sag, stretch and tape corrections. Slopes of over 5 degrees must be measured by a transit. All tapes used are to be certified as to length by the National Research Council. No tape which has been broken and subsequently repaired may be used if the break is within the measuring part of the tape.

Where triangulation is necessary, as across water or other obstacle, the distance is to be obtained by two triangles in accordance with the Manual of Instructions for the Survey of Dominion Lands.

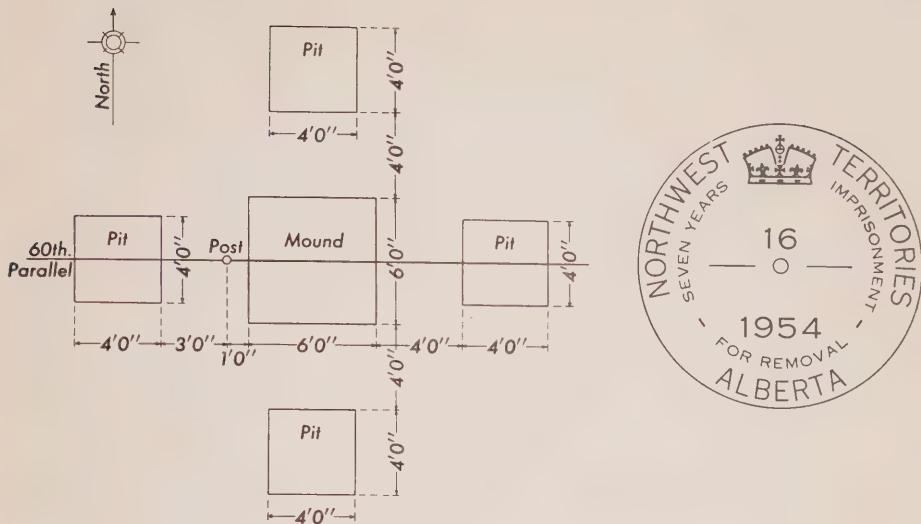
The accuracy of the chainage should be tested about once a month by more accurate methods and the results of the tests entered in the field notes as part of the returns of the survey. Using one of the spare tapes that is in good condition, an average section of line of about one-half mile in length should be remeasured, the tape being fully supported and under a tension of 20 pounds. Transfer points should be on hubs firmly driven into the ground and all slope measurements should be made with a transit or level. It is preferable to make the test on a cloudy day so that the temperature of the tape may be more accurately determined.

Monuments: Permanent monuments are to be erected on the boundary at intervisible points. An interval of about one to one-and-one-half miles between them is suitable; it should never exceed three miles. Each monument is to consist of a post stamped with its number and the year of the survey and is to be referenced by a pyramidal mound 6 feet square at the base and 30 inches high, and by four pits 4 feet square and 18 inches deep placed square with the boundary line in accordance with the diagram.

Where suitable rock in situ occurs at monument sites the rock posts should be leaded into a hole drilled into the rock. A mound made of stone may be substituted for the earth mound and the pits may be omitted where necessary.

Where possible soil posts should be set in concrete blocks 12 inches square at the top and 30 inches deep, the top being flush with the ground.

West of Slave River, monuments are to be numbered consecutively to the west using odd numbers only; east of Slave River they are to be numbered consecutively to the east using only even numbers.



Arrangement of monument components and typical marking
of special post cap, 1950-1954.

Clearing of Boundary: The boundary line is to be well cleared of trees and brush so as to give a sky line about 6 feet in width and is to be blazed. When a point of deflection at the terminal of a chord intervenes between two boundary monuments the straight line joining the monuments is to be similarly cleared and blazed.

Levels: Continuous differential spirit levels are to be carried along the line. Each portion of line is to be levelled and check-levelled to an agreement within 0.1 foot multiplied by the square root of the number of miles levelled. The elevations of the tops of all monument posts are to be recorded to the nearest one-hundredth of a foot. Bench marks which may be 6-inch spikes in blazed trees or a cross chiselled in solid rock are to be located adjacent to each monument and at other suitable points based on the rule that they should be spaced at intervals not exceeding one mile.

Positions on Air Photographs: The positions of all monuments and the points where the boundary line crosses rivers, creeks, lakes and other identifiable topography should be pinpointed on vertical air photographs and identified on the backs thereof with monument numbers and chainages.

Returns of Survey: The returns of the survey are to be in duplicate. They are to consist of:

1. General report.
2. Plan of survey at a scale of 40 chains to 1 inch, including a profile to the same linear scale with a suitable vertical scale.
3. A fair copy of the chainage notes.
4. The original astronomical observations for azimuth and time.

16 Alberta-Northwest Territories Boundary — 1924, 1925, and 1950 to 1954

5. A list of monuments erected including the number, description, azimuths and distances to adjacent monuments in each direction, and the elevations.
6. Pin-pointed vertical air photographs.
7. Official diary.
8. Original level books.
9. Original observations for magnetic declination.

Reproductions will be acceptable as duplicate copies. Duplicates are not required of the astronomical observations, level books, and magnetic observation.

Additional Instructions for Survey to Western Terminal

Prior to the commencement of the work projected for the 1951-52 season on the portion of the boundary west of the Mackenzie Highway, the Commission issued the following additional instructions:

The western terminal of the boundary is the northeast corner of the province of British Columbia. If this point is already established by the current survey of the Alberta-British Columbia boundary, it is to be used as the terminal of the most westerly section of the Alberta-Northwest Territories boundary after checking its latitude in reference to latitude observation station LAT. X.

If the corner is not established, the terminal point of the last section will be controlled by station LAT. X and the most westerly monument erected on the Alberta-Northwest Territories boundary will be at some suitable point about 20 chains easterly from it in order to make certain that it lies to the east of British Columbia. A temporary mark should be left on the 60th parallel, opposite station LAT. X, and this mark should be properly tied in to the last monument.

In such case, the tie from the northeast corner of British Columbia to the last monument will be made by the surveyor making the survey of the Alberta-British Columbia boundary.

Since the northeast corner of British Columbia had not been established when the western terminal of the Alberta-Northwest Territories boundary was reached, the following instructions were issued by the Alberta-British Columbia Boundary Commission with the concurrence of the Alberta-Northwest Territories Boundary Commission on October 8, 1952.

To locate the Northeast Corner of British Columbia: The terminal point is to be set at the intersection of the meridian boundary line between Alberta and British Columbia with the 60th parallel of north latitude as determined from latitude observation station LAT X, i.e., a straight line joining the terminal point and a point on the 60th parallel (to the north of latitude observation station LAT. X) should be perpendicular to the meridian through its mid-point. The monument is to be similar to the other monuments of the survey except that a special cap has been designed for the post. The post is to be embedded in concrete, or if aggregate is not available, in neat cement the purpose being to make it as permanent as possible.

To Complete Survey of Alberta-Northwest Territories Boundary to Western Terminal: The most westerly monument erected on the survey of the Alberta-Northwest Territories boundary is numbered 397. It is about 26 chains east of the northeast corner of British Columbia. The azimuth and distance between this monument and the terminal point is to be carefully measured and recorded. Since this course is part of the Alberta-Northwest Territories boundary a separate return for it is required.

Retracement and Level Ties: The azimuth and distance between Monuments No. 397 and 395 on the Alberta-Northwest Territories boundary, should also be carefully measured. The levels along the Alberta-British Columbia boundary should be tied to the levels along the Alberta-Northwest Territories boundary at bench marks numbered 259 and 258 on the latter boundary.

Additional Instructions for Survey to Eastern Terminal

The following additional instructions for the survey of the boundary from Slave River to its eastern terminal were issued by the Commission on April 23, 1954.

Monument No. 39, the terminus of the Saskatchewan-Alberta boundary is to be accepted as the terminal point of the survey. Differential spirit levels are to be carried forward from Monument No. 1 on a mean sea level datum and tied to the trigonometric elevations established on the Saskatchewan-Alberta boundary.

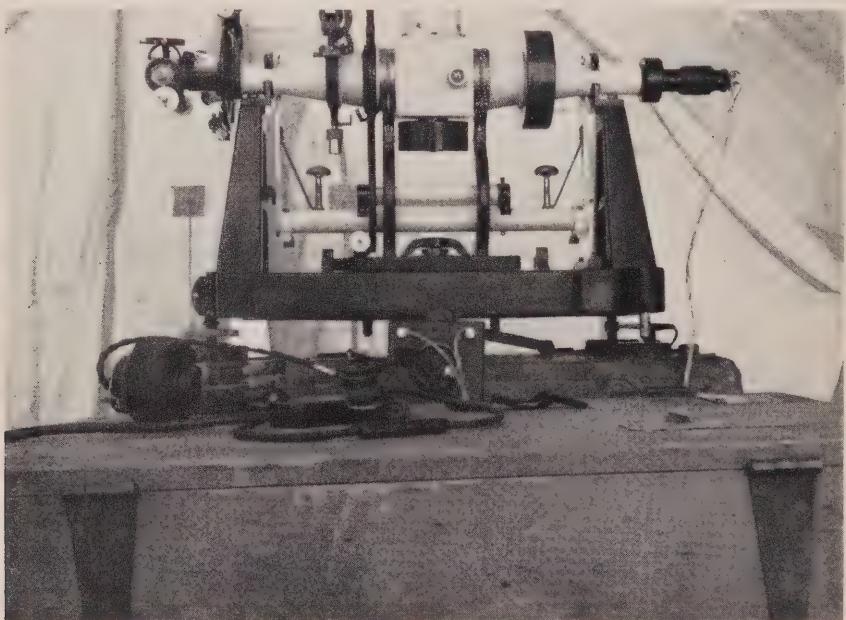
CHAPTER IV

ESTABLISHMENT OF CONTROL POINTS

In accordance with the Commission's request, the Geodetic Survey of Canada undertook to make the precise latitude observations required to control the survey of the boundary. Mr. W. D. Forrester of that Service was appointed to the task. The portion of this project west of Slave River was accomplished by two winter surveys made in 1949-1950 and 1950-1951 and the portion east of Slave River by a summer survey in 1952. The former required the occupation of ten latitude observation stations designated LAT. I to X and the latter, two stations designated F4 and F5.

The Commission is grateful to the Geodetic Survey and Mr. Forrester for the expeditious manner in which this work was carried out.

For the winter work, which is unusual for this type of precise observation, special preparations had to be made to ensure its success. The observing instruments which were to be used in an unheated observing tent were winterized, i.e.,



Heyde transit used for precise latitude and longitude determinations.
Note ear-phones and throat microphone in foreground.

all the grease and oil were removed and a special winter lubricant applied. By arranging telephone communication between the observing tent and a heated caboose it was possible for the recorder to remain in the latter together with the recording instruments, radio and all batteries except those used for the instrument lights. The observer's telephone was equipped with ear-phones and throat microphone in order to leave his hands free to manipulate the instrument. The instrument batteries were kept in an insulated box in the observing tent and were kept warm by a small kerosene car heater.

The transportation of the observing party and its heavy equipment in the field was by contract with a private company. Two tractors were used, with the usual difficulties of servicing on breakdowns and extraction from bog holes.

On February 8, one tractor became deeply mired in a boggy ravine. To accomplish its rescue a Caterpillar D8 tractor was brought from Hay River. Fifteen logs, 15 inches in diameter and 20 feet long, were cut at the Mackenzie



The T.D. 18 tractor mired in a bog.
Tripod of 20-foot spruce logs ready for removal operation.



The tractor being raised.

Highway and hauled to the scene, 25 miles to the east. A bombardier snowmobile made several 200-mile trips to Hay River for equipment, and forestry pumps were brought from Hay River by aeroplane in an unsuccessful attempt to lower the water in the bog hole. Eventually the tractor was raised by block and tackle, using the lighter tractor as an anchor and the D8 on the hoist cable. A tent was pitched over the rescued machine and after two days of constant heat it was again serviceable on March 2.

Mr. Forrester reports that on March 9 the light tractor refused to start. "The machine coughed and chugged two or three times to show that it was honestly trying, but, in its old age, it just didn't seem to have the will to live."

"We got in touch with Pat Monaghan (Geodetic Survey) on the radio and arranged for the T.D.18 to come back from Whitesand River to start it. The T.D.18 arrived next day and after being towed for 15 minutes steady, the light tractor finally woke up."

"...On April 3 (after completing the observation at LAT. I) we started the return trip to Hay River since it was far too late to contemplate tackling any further stations to the west of the highway. The trip back was trying because most of the snow had melted off the trail, and the T.D.18 had great difficulty pulling the sleighs over some bare spots. It was often necessary to break the train up and take it over the worst spots in two sections."

"Snags were quite troublesome both on the trip in and the trip out. These snags are trees lying in the trail or at the side of the trail, and if one wedges itself between the ground and part of the caboose, it will tear its way right through the floor or wall until it has run its course. Snags can be quite dangerous if anyone chooses to ride inside the caboose, although we, fortunately, had no injuries. One snag took the bench right out from under the cook; another came through the pantry scrambling a case of eggs and knocking over the heater stove; another broke the copper water reservoir off the cook stove; and still another one took a shelf of dishes off the kitchen wall..."

LAT. I to VI between the Mackenzie Highway and a point about 30 miles west of Little Buffalo River were observed during the winter of 1949-1950. It was expected that some of the points west of the highway would also be observed but delays due to tractor trouble made this impossible. The following



Caboose upset by rough muskeg on the westerly part of the boundary.

winter the program included LAT. VII to X between the highway and the northwest corner of the province and two other points westerly on the British Columbia-Northwest Territories boundary, but for the same reason the program had to be curtailed and the last two points were not observed.

This second winter, a D8 tractor was assigned to the party. By exercising greater care, it was never bogged down. However, on the extreme westerly part of the boundary, a reconnaissance made by air travel in the middle of February showed that the frost had not penetrated the muskegs in sufficient depth to bear the great weight of the D8 and a lighter International T.D.9 was added to the equipment. By plowing out the road with the T.D.9 and allowing two days for further freeze the D8 managed to reach LAT. IX. From there on to the Alberta-



"Teepee" of poles erected over latitude observation station.

British Columbia boundary the risk was too great. The T.D.9, by makeshift arrangements and arduous day and night travel, completed the job to LAT. X by March 16 and the return journey to the highway was commenced after essential repairs to tractor and caboose had been made.

During its use, repairs to the T.D.9 necessitated transportation of parts from Hay River by air.

In contrast to the winter work, the summer survey of 1952 to the east of Slave River was done without a hitch. Mr. Forrester left Ottawa by train on May 29 and arrived back home on June 27 with the mission successfully completed. Scheduled plane transportation was used between Edmonton and Fort Smith and charter plane service was used in the field operations. Latitude stations F4 on Donovan Lake and F5 on Charles Lake were established.

Only one uncomfortable experience, at Donovan Lake, is reported by Mr. Forrester. The aircraft grounded in mud about 100 feet from shore and the task of carrying the heavy equipment ashore through the soft, sticky mud proved to be an arduous and disagreeable task.

Table I gives the results of the observations with descriptions of the markers used to indicate the sites.

CHAPTER V

CONDENSED REPORTS OF BOUNDARY SURVEY OPERATIONS, 1950-1954

A considerable part of the country west of Little Buffalo River through which the boundary passes is flat swampy land with no natural hay growth to provide horse feed. Transportation for a survey party in the summer presented very great difficulties, so the most practical recourse was to undertake the work in the winter. For the unsurveyed section of the boundary to the east of Slave River, numerous lakes suitable for landing aeroplanes in either winter or summer are available. The summer was chosen for this work in order to facilitate monumentation.

Commencing in the early winter of 1950-51, three winters and one summer were required to complete the field work of the survey on September 1, 1954. Except for about 26 chains at the extreme western end, all the surveys of the $310\frac{3}{4}$ miles necessary to complete the demarcation of the boundary over its entire length of $346\frac{1}{2}$ miles were carried out by C. B. C. Donnelly, D.L.S., A.L.S.

Generally, the establishment of the survey parties comprised:

- 1 Chief of Party (C. B. C. Donnelly)
- 1 First Assistant
- 1 Leveller
- 1 Head Chainer
- 1 Cook
- 2 Labour Foremen
- 9 to 12 labourers as required.

1950-51 WINTER SEASON

The survey party was organized at Edmonton and Fort Vermilion, with W. M. Schwartz, D.L.S., as first assistant. It proceeded by truck to the starting point, LAT. VI, at the intersection of the 60th parallel with the Mackenzie Highway, reaching this point on December 3. During the previous winter, latitude stations LAT. VI, V, IV, III, II, and I, had been established between the Mackenzie Highway and Little Buffalo River (the western end of the 1925 survey) by the Geodetic Survey of Canada. The objective for the current season was to survey the boundary easterly from LAT. VI as far as possible, and during the winter $91\frac{1}{4}$ miles to LAT. II were surveyed and monumented.

Transportation in the field, the most difficult part of the survey operation, was satisfactorily arranged by Mr. Donnelly. The federal Department of Resources and Development agreed to lend the Commission two tractors and two sleighs stationed at Fort Smith. The Commission undertook to pay the running expenses, including the wages of the operators and the cost of any spring overhaul necessitated by their use on the work.

From an aerial inspection of the terrain to be crossed and the experiences of the latitude observing party the previous winter, it was evident that the swampy ground would not be sufficiently frozen to bear the weight of the tractors until some time in January. To provide transportation in the meantime, four teams of horses with fully equipped sleighs were hired at Fort Vermilion. A supply of hay and oats, calculated to last until January 10, was arranged. The tractors did not arrive at the survey camp until January 22. For the very trying interim period the survey party, 60 miles east of the Mackenzie Highway and 120 miles west of Fort Smith, was without transportation except for one dog team and toboggan.



Baled hay being transported by tractor train.

A Caterpillar D4 tractor with a 12-foot bulldozer blade and a D7 tractor with a 14-foot blade were used. The former was employed exclusively for moving camp, hauling wood, and general heavy transport until it broke down on February 27. The D7 was used for opening survey lines. Mr. Donnelly reports: "Given

adequate conditions of ground or frost, there is no means comparable to the tractor with dozer blade for clearing lines. A single passage is sufficient to clear a 6-foot sky line. It cleared as much as 9 miles in a single day and can average 4 miles per day. A camp space 60 feet square can be levelled and cleared of trees, dead fall, and snow in 15 minutes." From January 22 to March 17 the D7 tractor opened 30 miles of trial line and 90 miles of boundary. Three axemen, following the tractor, trimmed and blazed the boundary.

The purpose of trial lines is to determine the relative positions of successive latitude observation stations. These are usually about 24 miles apart. Since they govern the position of the boundary, the surveyor's first task is to determine their correlation with sufficient precision to permit him to lay out the boundary correctly. He must clear out and survey the trial line in such a way as to meet the prescribed angular tolerance of 6 seconds of arc.



Chaining table used on trial lines.

Mr. Donnelly attempted to save the time and cost of a trial line survey by floating an anchored 6-foot balloon 600 feet above the far point and reading the bearing to it from the near point with the transit. The experiment was not successful because the transitman was unable to sight the balloon.

A trial line was therefore surveyed as a succession of 486-chain chords to the supposed parallel, as established from LAT. VI. Upon reaching the vicinity of

LAT. V, the meridian distance from LAT. V to the trial line was measured. Having this, the surveyor was enabled to calculate the correct positions of the required monument sides on the true boundary, relative to intermediate points on the trial line.

Similar trial lines were surveyed between LAT. V and IV, IV and III, and III and II. For the sake of economy, the four trial lines were surveyed in succession easterly before any monuments were erected on the true boundary.

On February 20, the party commenced its return journey to the starting point of the survey, making the necessary measurements to set out the monument sites, erecting the monuments in their proper place on the boundary and clearing and blazing the respective lines between them. In this way, the boundary was marked by a series of permanent monuments, joined by a series of cleared and blazed lines, with 6-foot opening to the sky.

Differential spirit levels were carried forward along the trial lines with the accuracy specified in the instructions. Bench marks were later established on the boundary by transfer from the trial line. The elevations of the tops of all monument posts were recorded. The derived elevations are referred to mean sea level, as established by Geodetic Survey Bench Mark 866H, on the Mackenzie Highway.



Monument No. 141 as erected in 1951.



Monument No. 141 as it appeared in the fall of 1954.

Sixty-four monuments were erected to mark the $91\frac{1}{4}$ miles of boundary, an average of one monument for each $1\frac{1}{2}$ miles of line. They were numbered 141 to 267, in order westward, using odd numbers only. Table II gives the distance between successive monuments, the azimuth in one direction, and the elevations of the tops of the posts.

Monumenting in the winter is difficult and the results are usually not very satisfactory. The posts most generally used are 30 inches long with a flange at the bottom to prevent easy removal. Since they cannot be driven, a hole must be dug to allow the cap to be set flush with the ground. No matter how carefully the backfill is tamped, the post is liable to tilt with the return of warm weather and heave with continued thawing and freezing through the seasons.

The pits of the monument must be chopped out and the frozen soil thus removed is used to construct the mound. In the spring the soil thaws and the mound flattens out into a more or less shapeless mass.

The surveyor reports that he was unable to obtain aggregate for the construction of the concrete blocks required by his instructions.

The Commission expects that a restoration survey for the purpose of building more permanent monuments on the portions of the boundary surveyed in the winter will be required in a few years.

The excellent progress made in the survey demonstrates the value of tractors fitted with bulldozer blades. However, the tractors must be used with extreme care to prevent them from breaking through the frozen crusts of swamps or the ice on rivers and lakes. The surveyor reports that at least 10 inches of ice on narrow rivers is required to support the 17-ton weight of a Caterpillar D7 tractor. In muskeg, a frost depth of 15 inches is required. Open bog or swamp with ponds or cat-tails should always be avoided. Eighty-six barrels of tractor fuel were used in the operation.

Ninety-one and one quarter miles of the boundary, requiring the clearing of at least 183 miles of line, were surveyed in a bleak, desolate and swampy country in the short period of 3½ months. By walking to and from work in the dark, best use was made of the brief daylight for survey work. There were no lay-offs because of cold weather, even when the temperature reached its minimum of 65 degrees below zero.

With one minor exception, no sickness occurred. The only serious accident happened close to the Mackenzie Highway. One of the tractor operators was cut about the head when a bunt-pole in the tractor train broke when the train was descending the steep slope to Hay River. He was taken to Fort Vermilion by car for medical attention.

1951-52 WINTER SEASON

The objective for the 1951-52 winter season was the survey and monumentation of the boundary from the Mackenzie Highway westerly 104½ miles to the northeast corner of British Columbia. Mr. C. T. Cuff of Edmonton was the first assistant. Other personnel were from Edmonton, Fort Vermilion, and Paddle Prairie. Camp was established at the starting point on the Mackenzie Highway on November 7. Survey work commenced on the following day and was completed on March 15. Control for the location of the boundary included latitude observation stations LAT. VI, VII, VIII, IX and X, in succession westerly.

The camp was moved by four teams of horses with sleighs. Two Caterpillar D4 tractors were rented from time to time and were used for placing caches of supplies and horse feed at strategic points along the tractor trail which already existed near the boundary. One dog train and, later in the season, one motor toboggan were used for emergency transport and occasional movement of personnel undertaking retracement work.

From February 9 until the completion of the work, the tractors were used for clearing the 104½ miles of boundary line.

Between LAT. VI and VII an attempt was made to avoid clearing for a trial line by traversing the tractor road which lies roughly parallel to the boundary. However, the survey courses ascending the Cameron Hills proved to be too short



Horses and tents, 1951-52.

and steep to permit measuring the bearings and distances with the required precision. The idea was abandoned in favour of the normal method of surveying trial lines in 486-chain chords.

Considerable difficulty was experienced in maintaining the required accuracy of alignment. Frequent retracments were needed to disclose and measure errors. Some of these were, no doubt, caused by the stiffness of the transit instrument in the extremely cold weather. Other suspected causes were possible disturbance of line pickets by oil prospectors in the area and poor visibility due to fog and snow storms.

The same procedure as that used the previous winter was employed to clear and monument the boundary. This part of the work began on February 11 and was completed in the remarkably short time of 33 days. On the average, over 3 miles of boundary were cleared and monumented per day.

Since the survey of the Alberta-British Columbia boundary had not been completed by this time, no tie could be made to the northeast corner of British Columbia. The surveyor left a temporary mark on the 60th parallel just north of LAT. X and constructed his most westerly monument, No. 397, about 24 chains to the east.

Differential spirit levels were carried forward over the whole line from Geodetic Survey Bench Mark 866H, on the Mackenzie Highway. The first leveller employed was found to be physically unable to carry out the arduous task. A satisfactory replacement was obtained on December 12.

At the intersection with the previously-established sixth meridian of the Dominion Lands Survey system, a comparison of elevations indicated a discrepancy of about 7 feet. The section of line between meridian and the starting point was therefore relevelled on the return journey eastward. The result confirms the levels carried along the boundary.

The use of the tractors for clearing the boundary released enough men from other duties to allow the employment of three parties of two men each on monument building. By thawing out the pit sites with fire, unfrozen material was obtained for construction of the mounds. As a result, they will be more stable than those made with frozen soil. Each party constructed one mound per day. No posts were set in concrete blocks.

Sixty-five monuments, an average of one monument for each 1.6 miles of boundary, were constructed. Their numbers, using odd numbers only, are from 267 to 397, ascending westward. Details of the character of each monument, the distances and azimuths between successive monuments and the elevation of the top of each post above mean sea level are given in Table II.

The survey operations were made difficult by severe weather. Bitter north winds, from which the scattered tree growth offered little protection, caused many frost-bites among personnel. Snow, drifted by the winds, continually closed trails and piled in drifts up to 10 feet in depth, impeding transportation and other operations. Frequent snow storms and occasional fog sometimes prevented alignment processes. Clouded skies limited the opportunities for the all-important astronomic azimuth observations. Also, the Wild transit, although thoroughly winterized, stiffened in the extreme cold weather, adding to the difficulties of maintaining proper alignment.

The following extracts from the surveyor's official diary are pertinent:

December 1 — Snow storm all day. Cut 1 mile line. — Tractor still bogged down in beaver dam. Crew of 4 men and 1 team working to get it out.

December 10 — Very thick fog. Visibility $\frac{1}{4}$ mile. Breakfast 5 a.m. Sent 4 teams freighting. Sent dog train with Mr. Cuff (transitman). Doubt if he will be able to see in this fog.

December 13 — Temp. -30. Strong north wind. Many frost-bites, faces and fingers. Trail all drifted in. Unable to freight today.

January 19 — 74 below last night. Moved camp to site number 8. Many severe frost-bites today. Opened 2 miles of line, chained $1\frac{1}{2}$ miles, levelled $1\frac{1}{2}$ miles. Horses played out. Roughest muskeg I have ever seen.

February 24 — Searching for tractor crossing of Petitot River. Two wolves killed moose on Spawn Lake. Removed moose carcass for dog feed.

February 27 — Temp. -20. Some snow. — Made Monument 327. Four men unable to finish Monument 325 — boulders, clay and gravel. To avoid 7-mile walk in and out of camp, men slept out on line last night with food but no blankets.

February 29 — Malvin Beaulieu reported to be badly injured 11 miles from camp. Fell on his back on stump, unable to move.

March 1 — Beaulieu has broken ribs. Sent him out with team.

March 15 — Opened 3 miles of boundary completing winter work. First day of thaw this spring.

Oil prospectors were active in the area at the time of the survey, plowing out roads for their seismograph-equipped trucks as far west as Bistcho Lake. For staking purposes they were intensely interested in the location of the boundary — so much so that the surveyor felt obliged to warn them not to molest any pickets along the line. It is reported that one oil company had more than a dozen tractors working in the area.

Both vertical and horizontal ties were made to the sixth initial meridian in the Dominion Lands Survey system where it intersects the boundary at Monument 313. An approximate calculation from the boundary survey data indicates that the point of intersection is displaced from its theoretic position in the Dominion Lands Survey system by about $1\frac{1}{2}$ seconds of longitude and $\frac{1}{2}$ second of latitude. The discrepancy in the levels is now known to be less than 2 feet.

1952-53 WINTER SEASON

Organization and Program: On January 7, 1953, Mr. Donnelly and four technical assistants including D. Holmberg, first assistant, left Edmonton for Fort Smith by air. The remainder of the survey party was hired at the latter point. The program comprised the completion of the $51\frac{1}{2}$ -mile gap between Monument No. 141, established by Donnelly in 1951, and Monument No. 65, established by R. W. Cautley in 1925. In a westerly direction, the control points were, successively, Monument No. 65, LAT. I and Monument No. 141. The survey was completed on March 5.

In preparation for the survey of the boundary easterly from Slave River, a line was measured and levelled across the ice from Monument No. 1 to a temporary mark on the east bank. A temporary mark was left on Pemmican

Island in passing. This foresighted move proved to be of considerable assistance in the 1954 summer survey.

Until February 20, one Caterpillar D7 tractor, one dog team and one motor toboggan comprised the field transportation facilities. On that date a heavier Caterpillar D8 tractor, not equipped with bulldozer blade, was added. The tractors were on loan from the Department of Natural Resources and Development.



Moving camp by tractor train, 1952-53.



Tractor train and cabooses, 1952-53.

The D7, a relatively old machine, had five major breakdowns. These required the attention of expert mechanics from Fort Smith. In two cases, a cumbersome electric welder device was required to make the necessary repairs.

An expert guide was employed to find a safe trail over one particularly bad swamp which contained many open springs.

The customary 486-chain chord trial lines were surveyed westerly in the period between January 19 and February 17. The boundary proper was cleared and monumented between February 18 and March 4. In accordance with instructions, the courses between Monuments No. 141 and 143, established by Donnelly in 1951, and between Monuments No. 65 and 63, established by R. W. Cautley in 1925, were retraced.

Verified differential spirit levels were extended over the whole of the season's project, as on previous occasions. As a result of this, the elevations determined in 1925 by Mr. Cautley between Monuments No. 1 and 65 may now be adjusted to conform to the precise mean sea-level datum provided by Geodetic Survey Bench Mark 866H. Cautley's elevations were based on an assumed datum.

Monuments: Thirty-three monuments were erected on the boundary, the average interval between them being 1.6 miles. They were numbered 67 to 131, using odd numbers and a subsidiary number 83A. Details are included in Table II.

Monuments No. 65 and 63 were restored.

The surveyor reports that the personnel of the party proved to be very satisfactory. Only three men resigned on account of illness and no serious accidents occurred.

With the exception of three weeks of cold weather in January, the winter was one of rare mildness. On one day in February the temperature rose to 44 degrees above zero.

1954 SUMMER SEASON

On May 10, Mr. Donnelly with three assistants and a picketman flew from Edmonton to Fort Smith where the remainder of the party was recruited. Because of the lateness of the ice movement from Slave River, it was not possible to commence survey operations until May 25. Sixty-three and one-half miles of the boundary, from Monument No. 1 on the west bank of Slave River to Monument No. 39 at the northeast corner of Alberta, were surveyed and monumented by August 28. The survey was controlled by Monument No. 1, latitude observation stations F4 and F5 and Monument No. 39.

Camp moves were by man packing. Light camping equipment was used and food supplies were restricted to minimum current requirements. By arrangement,

a small pontoon-fitted aircraft brought fresh food from Fort Smith each week. This limited service was available only in the evenings after 6 o'clock. Toward the completion of the survey, a helicopter was used for a few camp moves.

A small canoe was carried to provide ferry service across the lakes and rivers intersected by the survey line and on occasion to move camp when suitable water routes were available.



The canoe being used in the 1954 season.

Previous surveys had shown that the 486-chain chord trial lines did not entirely accomplish the desired result of minimizing the distances between the trial lines and the true boundary. This was due to the unexpectedly large relative deviation of the vertical between successive latitude observation stations. The surveyor therefore adopted the simpler method of surveying straight trial lines between control points.

Chainage was carried forward by the usual method requiring two independent measures, one in chains and the other in feet. On the original chainage, steep slopes were measured by a hand clinometer only. The resulting measurements were sufficiently accurate for the calculation of the boundary offsets. To improve the accuracy of the measurements to be quoted as boundary dimensions, slopes were remeasured on the return journey westward when a transit was available for the purpose. About 25 miles of the trial lines were remeasured for the same purpose.

Thirty-eight triangulations across water were required.

Offsetting and monumenting the boundary commenced on July 19 and was completed on August 28. Both the trial and boundary lines were cleared by axemen.



Boundary line, looking west across Slave River and Pemmican Island.

An error was made in the trial-line calculations near Monument No. 24. Mr. Donnelly did not discover it until 15 monuments had been placed incorrectly and he then considered that the cost of making the correction was not warranted. As a result, Monuments No. 2 to 30 are north of their theoretic positions by amounts averaging 9 links (6 feet), the maximum displacement being 19 links (13 feet) at Monument No. 20. The area involved is about 15 acres, an addition to Alberta. The Commission recommends that no further expenditure be made to correct the error and that the boundary as now monumented be accepted.

With considerable difficulty owing to the uneven profile of the terrain, verified differential spirit levels were carried over the full length of the trial lines. Elevations are on mean sea-level datum. The elevations of the tops of all monument posts were recorded but in some cases the surveyor was unable to comply with the instruction to place bench marks on the boundary at intervals not exceeding one mile because suitable trees were not always available.

Owing to a misunderstanding, only an approximate tie was made to the trigonometric elevations established along the Saskatchewan-Alberta boundary.

Fifty monuments, or an average of one monument for each 1.3 miles of boundary, were erected. They are numbered 2 to 100 using even numbers only. The monuments are more stable than those erected in the winter and frequently the surveyor was able to cement the posts into solid rock and witness them with stone mounds.

The situation with regard to technical assistants became progressively worse as the survey of the boundary proceeded. Although prevailing rates of pay were offered, no trained men were obtained for the 1954 season's work and the surveyor was obliged to accept as transitman a graduate from a pre-medical course, as a chainer a law student, and as a leveller a man with high-school education. None had previous experience in survey work. During the enforced 12-day wait for the ice to move out of Slave River, Mr. Donnelly gave these men an intensive training course in the duties they were to carry out.

The weather during the season was generally good except that during July there was a great deal of rain. Two accidents were reported to the Workmen's Compensation Board. One man accidentally wounded himself with a shotgun, receiving the charge near the armpit. He was taken to Fort Smith by airplane. In the other case a man carrying a load fell and punctured his neck on a sharp tree stump. Other injuries were minor axe and knife cuts.

The surveyor's diary reports that on two days the party had no food and could catch no fish. Cooking was done over open camp fires throughout the season.

COMPLETION OF SURVEY TO WESTERN TERMINAL

The Survey of the Alberta-British Columbia boundary was completed on January 22, 1953, by G. Palsen, D.L.S., A.L.S. He marked its northern end with a monument numbered 127-1. The following day he measured the distance and azimuth to Monument No. 397 on the Alberta-Northwest Territories boundary, established by Donnelly in the winter season of 1951-52.

Palsen made a tie at this point between the differential spirit levels carried northward along the Alberta-British Columbia boundary and those carried westward along the Alberta-Northwest Territories boundary. Comparison of the derived respective elevations of the meeting point showed a remarkably small discrepancy of $1\frac{1}{2}$ feet.

FIELD INSPECTION OF SURVEY

Since none of the Commissioners was able at any time to visit the survey party and inspect the work in the field, Mr. John Carroll, D.L.S., was instructed on September 16, 1954, to make a spot check of the boundary for accuracy of distances and azimuths, to report on the construction and condition of monuments, and to observe the manner in which the boundary was cleared and blazed. Five well-distributed points were selected for the spot check.

Because of the inclemency of the weather and the imminent risk of being "frozen in", two of the points were not reached by the surveyor.

On November 14, 1954, C. M. Duncan, D.L.S., who was in the neighbourhood, inspected the boundary under the Commission's instructions at the point where it crosses the Mackenzie Highway.

Checks have also been made at the eastern and western ends and at the intersection with the west boundary of Wood Buffalo Park.

The latter was surveyed subsequent to the boundary survey and the point of intersection was monumented. An approximate calculation indicates a discrepancy between the two surveys of about 2 seconds of longitude and $\frac{1}{4}$ second of latitude. The unadjusted levels disagree by 3.8 feet.

The results of the inspections and checks indicate that the boundary "vista" has been well cleared, that the line has been blazed where suitable trees were available and that the monuments have been properly constructed. The winter-constructed monuments however have already deteriorated in some cases, leaving the posts projecting above ground level and the mounds distorted due to thawing and slumping.

The spot checks and survey connections indicate that the boundary surveyors have given due attention to the standards of precision indicated by their instructions. No important disagreement was found with the surveyors' reported dimensions. Since the check measures were, in principle, no more precise than the originals no conclusion can be made as to the absolute precision of the latter. The absence of gross disagreement as a result of random check is sufficient to warrant the conclusion that the survey has been carried out in a reliable manner.

DISPOSAL OF SURVEY RETURNS

All the returns of survey have been received, examined, and corrected where necessary, and placed on record at the Legal Surveys and Aeronautical Charts Division, Ottawa, and at the Surveys Branch, Edmonton. The observations for magnetic declination have been forwarded to the Dominion Astronomer for his records.

CHAPTER VI

GENERAL DESCRIPTION OF THE COUNTRY

The following description of the country through which the boundary passes is mainly derived from the surveyors' reports; where so indicated, they are quoted verbatim. Some additional material has been obtained from other sources. The elevations used in reference to topography have been taken from the profiles of the boundary prepared by the surveyors.

The material is arranged in divisions from east to west, according to the accomplishment in each survey season. Two survey seasons (winters 1950-51 and 1952-53) are grouped in the section from Little Buffalo River to the Mackenzie Highway. Since the surveys from Little Buffalo River westward were made in the winter, the opportunities for ground observation were limited by snow cover. As the characteristics of Hay and Slave Rivers are well-known, they are not described here.

FROM THE EASTERN BOUNDARY OF ALBERTA TO SLAVE RIVER

Topography. For a distance of about 48 miles from its eastern end, the boundary lies on the Canadian Shield. Characteristically, the surface is dotted with many lakes and broken with shallow steep-sided ravines. The largest of the lakes crossed by the boundary are Charles, Leland and Donovan Lakes. Charles Lake, with its many comparatively narrow arms, is 30 miles in length and drains northward to Taltson River. It is confined by steep rocky banks and is reported to be very deep. Leland Lake averages one-half mile in width and is 27 miles long. It drains to the south through Dog River into the Slave, opposite Fitzgerald. Donovan Lake, of about the same width, is 6 miles long. Both Donovan and Leland Lakes are subject to large variations in water level.

Tethul River, locally known as Hanging Ice River, is the only one of any size in the area. It drains Donovan Lake at its southerly tip, makes a wide loop and, 8 miles to the west, crosses the boundary. Thence it runs northerly to join Taltson River which flows into Great Slave Lake.

From a point four miles west of the northeast corner of Alberta, elevations decrease easterly from 1,264 feet to 1,120 feet at the corner and westerly to 740 feet at the edge of a swampy plain which extends 17 miles to the east bank of Slave River. Local undulations usually show ranges of elevation of less than 200 feet. Over the 17-mile plain there is a gradual drop of 30 feet to the top

of the 140-foot bank of Slave River. Although there is no pronounced rise at its eastern edge, it seems probable that most of this land was below the waters of Great Slave Lake when it was at the 700-foot level in the glacial retreat, the projections above the general plain then being islands.

The water elevation of Charles Lake is 927 feet, of Leland Lake 775 feet, of Donovan Lake 710 feet and of the Tethul River where it crosses the boundary 709 feet.

Forest Cover. The forest cover has no apparent commercial value. For a distance of 10 miles west from the eastern end of the boundary, drift soil in park-like areas supports stands of pine that reach a maximum diameter of 8 inches. The intervening valleys are spruce-covered muskegs. An area with many rock exposures extending westerly to Tethul River has, generally, a coverage of pine of small diameter. The swampy plain extending to Slave River supports small spruce with areas of willow and floating tamarack bogs. Along the shores of Charles and Donovan Lakes and the banks of Tethul River are scattered small stands of fine spruce. On Pemmican Island in Slave River, there is a thick growth of spruce reaching 15 inches in diameter.

The boundary passes through 6 miles of jackpine killed by fire in 1952.

Minerals. Mining development has not occurred in the immediate vicinity of the boundary and no claim-staking was seen by the survey party, although one



Typical country.



Typical country.

prospector visited the survey camp. The surveyor reports seeing one quartz vein 10 to 20 feet wide and many about 6 inches wide.

Game and Fur. Mr. Donnelly reports:—"The area has been trapped by some members of the survey party. They say there is a plentiful supply of beaver and fox, and some fisher, otter and marten. Bear is plentiful, moose abundant, but grouse, ducks and geese are very scarce."

During some winters, usually in January, barren-land caribou come to this area and numerous trails worn deep in the moss are evidence of their passage. There are wolves, some in summer and many in winter. Rabies is said to have been prevalent among them and to have taken a heavy toll of all wild animal life.

FROM SLAVE RIVER TO LITTLE BUFFALO RIVER

Slave River to Salt River. "From Slave River to Salt River a distance of 18½ miles, the boundary crosses nearly flat country, lying between the two rivers, which has a slight but uniform slope towards Salt River."

"The surface alternates between willow and grass marshes and scarcely higher land covered with jackpine, aspen and spruce up to 10 inches diameter."

"Owing to the extreme flatness of the country there are no creeks giving direct drainage, and much of the surface is very wet during the early part of the summer owing to delayed run-off after the spring thaw."

"The subsoil is everywhere a fine, yellow sand and it is noticeable that there are no stones of any kind."

"Salt River is a pretty stream from 60 to 130 feet wide, flowing about one mile per hour between banks that are from 8 to 12 feet high. It varies in depth from 2 to 6 feet and the channel is full of subaqueous weeds. The water is nearly as salty as sea-water and many of the small streams that enter it from the southwest, or [Salt Mountain], side are supersaturated with salt."

Salt River to Little Buffalo River. "West from Salt River, after crossing half a mile of salt-encrusted flats, the line rises abruptly about 200 feet to the top of what appears from the east to be a high ridge, known as [Salt Mountain], but which in reality is the easterly edge of a nearly level plateau that extends as such all the way to Little Buffalo River — about 17 miles. This plateau is principally covered with jackpine, aspen and spruce up to a maximum of 14 inches diameter. The surface is more level but not quite so even as it is east of Salt River, the ridges being more marked in character and there being a number of what have been called "sink-holes". Sink-holes are depressions from 20 to 40 feet deep which generally occur in series but are not connected with one another by surface channels; they have the appearance of subsidences that have taken place along the line of ancient mine workings. There are scattered willow and grass marshes. There are no creeks and in one place along the line there is no water of any kind for 6½ miles. In contrast to the land east of Salt River, the soil is very stony in places."

"Little Buffalo River, where the boundary crosses it, is a sluggish stream about 66 feet wide between timbered banks about 8 feet high. The water is dirty looking but is not salty".

Old Lake Bottom. Geographers describe the flat country between Slave and Salt Rivers as being part of the lake bottom of Great Slave Lake during one period of the glacial retreat. Its elevation at Slave River is 694 feet above sea level. It gradually descends to an elevation of 570 feet at Salt River.

The Escarpment. The high ridge [Salt Mountain] is the easterly edge of an escarpment which continues northwesterly to cross Hay River at Alexandra Falls and Kakisa River, about 2 miles south of Kakisa Lake. To the south of the boundary this elevated area is called Ninishith Hills. The escarpment was probably the shore line of Great Slave Lake when it was at about the 700-foot level.

NOTE:—Names in brackets are not confirmed by the Canadian Board on Geographical Names but are based on local usage.

Sink-holes. The sink-holes described by Mr. Cautley may have been caused by subsidence following the dissolving of gypsum by underground streams. The Sass River, immediately to the north of the boundary, is an example of an underground stream. It disappears underground and, farther along, reappears on the surface to continue its course to Little Buffalo River.

FROM LITTLE BUFFALO RIVER TO THE MACKENZIE HIGHWAY

Topography. The area is an alluvial plain of extensive muskegs and bogs interspersed with low ridges of boulder clay. The drainage flow, carrying the run-off water from the Caribou Mountains which lie to the south, is all northward to Buffalo Lake and thence to Great Slave Lake. The chief drainage arteries are [Copp], Buffalo, Whitesand and Yates Rivers, in that order westerly. They are shallow, sluggish streams. Their depth in winter is less than $2\frac{1}{2}$ feet in the vicinity of the boundary. Other small creeks, some with no definite pattern and with little flow, are found in the swamps.



Country east of Mackenzie Highway.

Many shallow lakes are found in the area that lies between points 24 miles west and 40 miles east of Buffalo River. In the easterly 12 miles of this section are numerous sulphur and salt springs that do not freeze in winter.

There is little change in elevation over the 143 miles of boundary. From an elevation of 758 feet above sea level at its easterly end, the ground gradually rises to between 840 and 860 feet. This elevation is maintained, with slight variations, for a distance of 12 miles. From this point westerly to the Mackenzie Highway, a distance of 125 miles, the ground elevation is fairly constant between 900 and 1,000 feet. A few points lie above the 1,000-foot elevation.

The elevation of Little Buffalo River at the boundary crossing is about 750 feet, of [Copp River] 960, of Buffalo River 928, of Whitesand River 902 and of Yates River 963. Hay River, where the boundary crosses, is 932 feet above sea level. For comparison, Great Slave Lake, which lies about 60 miles to the north and to which all this water drains, has a water elevation of 519 feet.

Forest Cover. Fine spruce, up to 16 inches in diameter, is found on the banks of Little Buffalo River, Tourangeau Creek, Whitesand and Hay Rivers. Many low ridges supporting jackpine and a few with small aspen rise above the spruce muskegs and tamarack swamps. To a great extent, tree growth away from the rivers and streams has been killed by fire. Even forest debris has been burned on some ridges, leaving them bare.

Minerals. "South of the boundary many oil outfits are making explorations. In the spring of 1950, heavy machinery was moved into Fort Vermilion for drilling operations to the east."

"No mineral was seen along the boundary line, except indications of the presence of sulphur manifesting itself in the unfrozen water of rivulets and creeks."



Standing fire-killed trees provided good firewood.



The boundary line in spruce-muskeg country.

The Pine Point lead-zinc ore development lies about 60 miles north of the boundary. Underlying gypsum beds are known to exist in the area and salt deposits, sufficient for local use, are found in the vicinity of Salt River.

Soil. In the muskegs and swamps the soil is the usual peat bog. In the spruce muskegs, the moss often extends to a depth of 20 inches with a subsoil of muck containing, in places, some clay.

Hard clay, mixed with gravel and covered by a few inches of humus, is found along the narrow valleys of the Yates, Whitesand and Buffalo Rivers. On the low pine and aspen ridges the soil is boulder clay but no surface-free boulders or rock outcrops are evident.



Barren Lands caribou.

Game and Fur. Seven buffalo were seen by the survey party in the eastern area but none in the western part. Their main grazing areas are east of Little Buffalo River.

"The barren-land caribou flooded the country east of the Whitesand River early in January. Thousands and thousands crossed and recrossed the line. One herd trotting across the line seven to ten abreast took an hour to effect passage." Numbers of caribou carcasses slain by wolves were found.



Mink.



Wood bison.

"Mink are plentiful along the creeks and many tracks were observed; many foxes roam the country; muskrat and beaver were in evidence but not plentiful; no marten were seen or tracked. Ptarmigan and prairie chicken were numerous."

FROM MACKENZIE HIGHWAY TO THE NORTHWEST CORNER OF ALBERTA

Topography. The main physical feature in the area is the Cameron Hills, formerly known as Eagle Mountain. The eastern slope commences about 2 miles west of the highway. It gradually ascends 475 feet in the first 6 miles. In the next 3 miles there is a sharp rise of 880 feet. The first crest on the boundary, 1,470 feet above the highway or 2,438 feet above sea level, is reached 1½ miles farther west. The greatest elevation on the line is 2,504 feet at Monument No. 289, 17 miles west of Mackenzie Highway.

There is no distinct western edge to the plateau. From its maximum height on the line, it descends, with local irregularities, to elevation 2,100 feet at 36 miles from the highway and to 1,950 feet at the Petitot River crossing, 6 miles farther west. Continuing west, the ground rises to 2,085 feet and falls again to 1,885 feet at the [second crossing of Petitot River] on its way south through Spawn Lake. West of this, there is a stretch of 27 miles of flat terrain at elevation about



The boundary line west of Mackenzie Highway.

2,000 feet. In the next 27 miles, to the western end of the boundary, the ground descends gradually to elevation 1,500 feet.

"On top of the mountain the undulating plateau is one of muskeg with ridges of jackpine and some aspen. Small rounded hills occur in the swamp, which possibly are moraines. Approaching the 6th meridian at mileage 35 the country becomes more rugged and rolling, marred by extensive burn of the jackpine coverage. Many small lakes are scattered throughout the plateau." The muskeg on the westerly half of the line is featured by high moss hummocks.

"The mountain divides the watersheds of Hay and Petitot Rivers. The drainage of creeks from the plateau is generally south and southwesterly, except the large creek near Monument No. 397 (mileage 104) which flows north. The



Timber on the east slope of the Cameron Hills.

Petitot River waters flow into Bistcho Lake (elevation about 1,812 feet) and thence to Liard River."

The two largest lakes crossed by the boundary are Spawn Lake and an unnamed lake between Monuments 355 and 357, 5 and 6 miles long respectively.

Forest Cover. The eastern slope of Cameron Hills is heavily timbered with spruce up to 20 inches in diameter. "On the plateau, except along the creeks, there is no timber in excess of 6 inches. The country has been ravaged by fire. It has never been a big-timber country, being all spruce muskeg with the exception of low ridges of jackpine and some spruce. There are many willow swamps intersecting the muskegs."

Minerals. No mineral occurrences were reported.

Game and Fur. "Moose are plentiful in a few areas where there is good feed. The westerly shore of [Swamp Lake] abounds with moose, as the willow growth there is prolific. Further west, 7 moose were observed in one day. Caribou are also plentiful."

"Wolves were numerous. We witnessed the destruction of a moose by 2 wolves on the ice of [Swamp Lake]. One wolf was shot at across our campfire." Foxes are plentiful as are lynx on the eastern slope of the Cameron Hills. Marten tracks were seen in the vicinity of the 6th meridian.

"Whitefish, which attain a weight of 5 pounds, are found in some of the lakes adjacent to the boundary."

CHAPTER VII

CONCLUSION

Following completion of the field work involved in the survey of the boundary, the Commission was concerned mainly with examination of survey returns, preparation of final map sheets, and compilation of this report.

The Commission is satisfied that the surveys performed in 1924 and 1925 and 1950-54 constitute adequate demarcation of the boundary between Alberta and the Northwest Territories.

The surveys were conducted expeditiously under difficult conditions of terrain, weather, and transport facilities and, generally, with comparatively inexperienced technical assistants. Under these circumstances their successful completion is a credit to the surveyors.

In the following respects, however, the surveyors did not wholly fulfil the intent of their instructions:

1. In 1925, owing to difficult weather conditions, a minor error of survey occurred. It favors the Northwest Territories to the extent of some 7 acres.
2. In 1954, a similar error affected the placement of 15 boundary monuments. It favors Alberta to the extent of about 15 acres.
3. Random inspections and connections to other surveys indicate that the precision of measures of distance between monuments is possibly not as high as had been expected.

When it is realized that what are here termed "errors" are simply failures to achieve a certain standard of precision, rather than blunders, the wisdom of attempting to improve the condition becomes very doubtful. The estimated net effect is to allot about 8 acres of undeveloped territory to Alberta rather than the Northwest Territories, and the cost of adjusting the survey would be completely out of proportion to the value represented. The indicated possible inferiority of precision of quoted distances between monuments has no practical effect on the division of territory. The Commission therefore considers that the boundary, as now monumented, should be confirmed by appropriate legislation.

That is to say:

1. The boundary line between the Province of Alberta and the Northwest Territories, defined by survey monuments established on the ground pursuant

to the instructions of the Department of the Interior in 1925 and the instructions of the Alberta-Northwest Territories Boundary Commission during the years 1950 to 1954 inclusive and as shown on map sheets numbered 1 to 20 inclusive and signed by the members of the Commission, should be accepted as the true boundary between the said Province and Territories.

2. The Government of the Province of Alberta should submit to the Legislative Assembly a bill for an Act consenting to declaration by the Parliament of Canada of the above-described boundary line as the true and unalterable boundary between the Province of Alberta and the Northwest Territories.

It is also considered that the functions of the present Boundary Commission should in future include the execution of such re-surveys, line clearing and restorative work as may appear necessary from time to time to maintain the present boundary vista and monuments in a good state of preservation. The present basis of sharing of costs should be extended to these new duties.

In concluding this report, it seems advisable to point out an anomalous circumstance which exists with respect to Fort Smith Settlement. Lot 11 therein was surveyed and granted by Letters Patent prior to the boundary survey of 1925. Part of this lot extends about 56 inches south of the boundary which it is now proposed to confirm. As the proposed confirmation might act to cast a cloud upon the existing title to Lot 11, we suggest that arrangements be made with the owner and the Land Registry authorities for the execution and registration of such transfers of that portion of the lot lying south of the boundary as may be necessary to validate the records of ownership subsequent to ratification of the position of the boundary. In this way, the previous commitments of both the Province and the Dominion would apparently be honoured.

The atlas which accompanies and forms part of this report comprises twenty map or plan sheets. It forms a complete description of the boundary, as surveyed.

Each atlas sheet covers about $17\frac{1}{3}$ miles of the boundary and extends through 30 minutes of geographic longitude. The position and nature of each boundary monument is shown, together with the surrounding topographic detail.

The topographic detail is derived from the observations of the surveyors on or near the actual boundary and supplemented by reference to aerial photography. In this way, the physical position of the boundary with relation to natural or cultural features is readily comprehended.

The geographic position of the boundary, with respect to the North American 1927 datum, was derived from a connection to a Shoran station at Fort Smith. For this derivation, the Shoran station position was taken to be latitude $59^{\circ}59'57".88$, longitude $111^{\circ}50'17".13$. These geographic values are subject to further adjustment.

The ground profile of the boundary vicinity is also shown, plotted in such a way as to provide an appreciation of the nature of the terrain traversed by the boundary.

The locations of bench marks established during the boundary survey are shown on the profile, and their elevations. The elevations of the boundary monuments are also shown. These elevations are derived from Geodetic Bench Mark 866H, situated at the Mackenzie Highway and having an elevation of 971.075 feet above mean sea level. In this way, future surveyors are provided with convenient elevation references all along the boundary.



Monument No. 123.



Monument No. 131.



Monument No. 227.



Monument No. 295.



Monument No. 305.



Monument No. 365.



Bench Mark No. 83.



Typical monuments with rock and earth mounds, erected in summer of 1954.

TABLE I

LATITUDE OBSERVATION STATIONS

Controlling Survey of the Alberta-Northwest Territories Boundary

Identification	Observed Longitude (Astronomic)	Observed Latitude (Astronomic)	Marker
	° ' "	° ' "	
F5, 1952	110 35 00.66	66 00 00.02	I.P.S.M.
F4, 1952	111 14 46.18	59 59 48.34	I.P.M.T.
Engler, 1910	Not observed	60 00 35.98	I.P.M.T.
Parry 1, 1924	" " "	60 00 16.51	Wo. M.T.
Parry 2, 1924	" " "	59 59 55.79	Wo. M.T.
Parry 3, 1924	" " "	60 00 10.09	Wo. M.T.
LAT I, 1950	113 47 01.33	60 00 17.30	I.P.M.T.
LAT II, 1950	114 21 05.00	60 00 14.29	I.P.M.T.
LAT III, 1950	114 49 52.88	60 00 13.91	I.P.M.T.
LAT IV, 1950	115 35 56.40	59 59 50.09	I.P.M.T.
LAT V, 1950	116 04 58.62	59 59 57.69	I.P.M.T.
LAT VI, 1950	116 58 44.8	60 00 00.46	I.P.M.T.
LAT VII, 1951	117 45 17.82	59 59 57.33	I.P.M.T.
LAT VIII, 1951	118 41 51.12	60 00 03.35	I.P.M.T.
LAT IX, 1951	119 20 19.6	60 00 10.46	I.P.M.T.
LAT X, 1951	119 59 51.18	59 59 56.03	I.P.M.T.

Abbreviations: P.—Standard Post. I.P.— $\frac{3}{4}$ " Iron Post. T.—Trench. S.—Stone. M.—Mound.
Wo.—Wooden Post.

TABLE II — SUMMARY OF MONUMENT DATA

MONUMENT		DISTANCE		Azimuth To Forward Monument ° ' "	Elevation feet Above M.S.L. (Top of Post)
No.	Type	From Miles	East Terminal Chains	To Forward Monument Chains	
39	P.S.M.	0	0	68.612	270 01 33
100	P.S.M.	0	68.612	149.745	270 03 08
98	P.Pit.M.	2	58.357	110.783	270 03 27
96	P.Rock S.M.	4	09.140	79.681	270 01 23
94	P.S.M.	5	08.821	158.166	269 59 53
92	P.Rock S.M.	7	06.988	35.750	269 56 57
90	"	7	42.738	169.301	270 03 50
88	"	9	52.039	198.167	270 02 12
86	P.3Pits M.	12	10.205	95.500	269 58 28
84	P.Rock Pit.M.	13	25.705	50.765	269 56 40
82	P.Pit.M.	13	76.470	61.291	270 04 35
80	P.Rock S.M.	14	57.760	182.620	270 03 40
78	"	17	00.380	38.459	270 00 18
76	"	17	38.839	85.735	269 59 32
74	"	18	44.574	102.042	269 57 56
72	"	19	66.616	17.492	269 56 03
70	"	20	04.107	135.231	270 00 11
66	"	21	59.338	84.029	269 57 39
64	P.Pit.M.	22	63.367	102.849	269 56 04
62	P.Rock S.M.	24	06.217	43.257	269 54 09
60	P.Pit.M.	24	49.473	184.911	270 00 49
58	P.Rock S.M.	26	74.384	110.692	269 58 04
56	"	28	25.077	128.541	269 56 03
54	"	29	73.618	143.313	269 57 49
52	"	31	56.931	76.970	270 00 03
50	"	32	53.901	157.095	269 58 36
48	"	34	50.996	107.231	269 55 39
46	"	35	78.227	116.645	269 56 39
44	"	37	34.872	97.727	270 00 31
42	P.S.M.	38	52.598	67.531	269 58 42
40	P.Rock S.M.	39	40.129	104.540	269 56 59
38	"	40	64.669	80.114	269 55 33
36	"	41	64.783	99.005	269 54 03
34	P.Pit.M.	43	03.788	29.360	269 59 50
32	P.Rock S.M.	43	33.148	117.294	269 59 21
30	"	44	70.442	107.327	270 01 29
28	"	46	17.770	117.797	270 01 26
26	"	47	55.567	165.052	269 59 17
24	"	49	60.618	107.644	269 58 13
22	"	51	08.262	78.803	270 00 17
20	P.Pit.M.	52	07.065	85.339	270 00 20

Monument 39 marks the northeast corner of Alberta, i.e., the fourth initial meridian, Dominion Lands Survey System.

TABLE II — SUMMARY OF MONUMENT DATA — (continued)

No.	Type	DISTANCE			Azimuth To Forward Monument ° ' "	Elevation feet Above M.S.L. (Top of Post)
		From Miles	East Terminal Chains	To Forward Monument Chains		
18	P.Pit.M.	53	12.404	76.388	269 58 44	726.28
16	P.Rock S.M.	54	08.792	82.211	269 57 21	747.51
14	P.Pit.M.	55	11.003	96.274	269 55 50	719.18
12	P.Rock S.M.	56	27.277	57.126	269 54 02	725.89
10	P.Pit.M.	57	04.403	148.670	270 00 07	712.88
8	"	58	73.073	125.451	269 59 14	702.70
6	"	60	38.524	109.369	269 56 53	719.43
4	"	61	67.893	49.621	269 54 50	712.48
2	"	62	37.514	83.950	269 53 54	—
1	P. Pier	63	41.464	106.534	270 04 09	694.32
3	P.(Buried)	64	67.998	63.233	270 03 46	674.65
5	P.2 Pits M.	65	51.231	111.227	270 04 11	681.98
7	"	67	02.458	58.666	270 03 42	672.76
9	"	67	61.124	111.968	270 04 15	682.67
11	"	69	13.092	119.217	270 04 16	664.49
13	"	70	52.309	101.929	270 04 03	664.09
15	"	71	74.238	118.536	270 04 19	647.94
17	"	73	32.774	78.979	270 03 54	640.32
19	"	74	31.753	117.395	270 04 16	631.22
21	"	75	69.148	19.620	270 03 09	626.08
23	"	76	08.768	35.850	269 58 26	625.15
25	P.2 Pits M.	76	44.618	79.334	269 58 46	630.69
27	"	77	43.952	95.345	269 58 58	618.33
29	"	78	59.297	82.503	269 58 50	608.82
31	"	79	61.800	92.231	269 58 55	586.02
33	"	80	74.031	76.052	269 58 48	575.37
35	"	81	70.083	98.175	269 57 17	570.41
37	P.S.M.	83	08.258	22.330	269 56 34	743.68
39	"	83	30.588	63.302	269 56 53	773.23
41	P.2 Pits M.	84	13.890	109.842	269 57 23	786.96
43	"	85	43.732	112.561	269 57 25	787.26
45	"	86	76.293	98.141	269 57 13	770.29
47	"	88	14.434	113.270	269 57 24	744.52
49	"	89	47.704	35.192	269 56 40	761.28
51	"	90	02.896	99.066	269 57 15	743.16
53	"	91	21.962	111.179	269 57 43	726.50
55	"	92	53.141	101.757	269 57 35	776.47
57	"	93	74.898	119.359	269 57 58	743.03
59	"	95	34.257	115.872	269 57 58	812.93
61	"	96	70.129	102.087	269 58 10	775.84
63	"	98	12.216	83.680	269 57 56	766.23
65	"	99	15.896	134.026	270 03 22	758.44

TABLE II—SUMMARY OF MONUMENT DATA—(continued)

MONUMENT		DISTANCE			Azimuth To Forward Monument ° " "	Elevation feet Above M.S.L. (Top of Post)
No.	Type	From Terminal Miles	East Chains	To Forward Monument Chains		
67	P.Pit.M.	100	69.922	175.873	270 00 51	769.31
69	"	103	05.795	79.348	269 57 34	799.14
71	"	104	05.142	100.035	269 56 22	837.68
73	"	105	25.178	85.812	270 03 18	841.49
75	"	106	30.990	126.289	270 01 42	846.03
77	"	107	77.279	122.910	269 59 19	842.64
79	"	109	40.190	113.077	269 57 02	849.86
81	"	110	73.266	91.109	270 00 33	856.41
83	"	112	04.375	213.638	270 02 18	865.23
83A	"	114	58.013	101.757	269 58 18	867.04
85	"	115	79.770	62.835	269 56 24	900.27
87	"	116	62.605	115.598	270 00 18	893.77
89	"	118	18.203	127.141	270 02 09	944.75
91	"	119	65.345	123.738	269 59 47	928.62
93	"	121	29.083	133.262	269 57 28	909.03
95	"	123	02.344	182.004	270 02 11	903.39
97	"	125	24.349	77.358	270 00 39	916.84
99	"	126	21.707	124.234	269 59 10	925.56
101	"	127	65.941	110.516	269 56 53	921.45
103	"	129	16.457	143.491	269 59 15	941.96
105	"	130	79.948	164.942	270 03 12	928.26
107	"	133	04.890	105.701	270 00 07	959.94
109	"	134	30.591	129.987	269 58 08	962.46
111	"	136	00.578	65.550	269 55 42	971.61
113	"	136	66.128	72.460	270 01 05	964.50
115	"	137	58.588	149.483	270 02 13	969.75
117	"	139	48.071	104.250	269 59 25	963.73
119	"	140	72.321	112.581	269 57 28	977.12
121	"	142	24.902	118.722	269 59 19	1008.39
123	"	143	63.624	89.101	270 02 14	964.54
125	"	144	72.724	108.874	270 00 34	972.32
127	"	146	21.598	128.243	269 58 32	989.78
129	"	147	69.841	164.208	269 58 07	979.38
131	"	149	74.049	63.987	269 58 44	970.40
141	"	150	58.037	163.635	269 58 25	1023.88
143	"	152	61.671	107.169	269 55 21	954.85
145	"	154	08.841	94.701	269 53 48	945.19
147	"	155	23.542	114.614	269 59 30	942.92
149	"	156	58.155	141.307	269 57 21	958.75
151	"	158	39.463	109.232	269 54 42	955.12
153	"	159	68.695	112.396	269 52 39	963.76
155	"	161	21.091	106.639	269 59 25	967.92

TABLE II—SUMMARY OF MONUMENT DATA—(continued)

No.	Type	DISTANCE			Azimuth To Forward Monument ° ' "	Elevation feet Above M.S.L. (Top of Post)
		From Terminal Miles	East Chains	To Forward Monument Chains		
157	P.Pit.M.	162	47.730	145.018	269 57 40	996.73
159	"	164	32.748	99.268	269 54 56	981.74
161	"	165	52.016	137.934	269 53 05	1002.01
163	"	167	29.950	73.646	270 02 19	1003.89
165	"	168	23.596	91.901	270 00 57	1003.18
167	"	169	35.497	279.088	270 05 02	1002.55
169	"	172	74.585	78.888	270 00 18	999.96
171	"	173	73.473	59.617	269 58 49	1012.88
173	"	174	53.090	93.780	269 58 02	1024.96
175	"	175	66.870	109.394	270 05 04	1021.10
177	"	177	16.264	83.151	270 03 01	1016.39
179	"	178	19.415	103.371	270 01 27	1016.23
181	"	179	42.786	123.039	269 59 31	1010.84
183	"	181	05.825	99.208	270 00 28	1029.47
185	"	182	25.033	109.399	270 04 27	999.68
187	"	183	54.432	90.956	270 02 24	1005.59
189	"	184	65.388	89.825	270 00 42	1006.20
191	"	185	75.213	113.333	269 59 01	1032.51
193	"	187	28.546	101.688	270 01 48	976.46
195	"	188	50.234	103.554	270 04 06	954.30
197	"	189	73.788	93.539	270 02 09	960.12
199	"	191	07.327	141.974	270 00 24	941.38
201	"	192	69.301	92.153	269 57 44	934.56
203	"	194	01.454	123.030	270 04 58	933.53
205	"	195	44.484	106.390	270 02 40	960.49
207	"	196	70.873	108.702	270 00 40	958.96
209	"	198	19.575	128.841	270 04 34	962.42
211	"	199	68.416	101.947	270 04 15	956.63
213	"	201	10.363	110.557	270 02 21	965.04
215	"	202	40.919	87.840	270 00 16	957.83
217	"	203	48.759	90.247	269 58 38	970.05
219	"	204	59.006	100.246	270 06 02	964.60
221	"	205	79.252	72.964	270 04 10	957.54
223	"	206	72.216	118.010	270 02 48	950.04
225	"	208	30.226	95.105	270 00 35	948.20
227	"	209	45.330	99.878	269 58 48	960.30
229	"	210	65.209	131.305	270 13 19	974.15
231	"	212	36.514	126.819	270 13 11	998.66
233	"	214	03.333	170.485	270 10 49	1006.01
235	"	216	13.818	116.769	270 07 37	1016.18
237	"	217	50.587	164.176	270 14 30	1009.58
239	"	219	54.762	111.906	270 11 28	989.22

TABLE II—SUMMARY OF MONUMENT DATA—(continued)

No.	MONUMENT Type	DISTANCE		Azimuth To Forward Monument ° "	Elevation feet Above M.S.L. (Top of Post)
		From Miles	East Terminal Chains		
241	P.Pit.M.	221	06.668	139.358	270 09 22
243	"	222	66.026	135.922	270 11 05
245	"	224	41.947	142.874	270 13 19
247	"	226	24.821	123.981	270 10 38
249	"	227	68.802	115.398	270 08 19
251	"	229	24.200	111.834	270 12 05
253	"	230	56.035	138.225	270 13 10
255	"	232	34.260	114.270	270 10 34
257	"	233	68.530	160.673	270 08 26
259	"	235	69.202	129.654	270 14 31
261	"	237	38.856	125.257	270 12 06
263	"	239	04.112	115.366	270 09 45
265	"	240	39.478	115.919	270 07 35
267	"	241	75.397	130.876	270 06 12
269	"	243	46.273	123.343	270 03 45
271	"	245	09.615	145.642	270 01 26
273	"	246	75.257	86.140	269 58 43
275	"	248	01.397	117.199	270 06 12
277	"	249	38.596	163.692	270 04 00
279	"	251	42.287	133.474	270 00 56
281	"	253	15.761	121.733	270 02 11
283	"	254	57.494	108.801	270 05 16
285	"	256	06.295	134.107	270 03 13
287	"	257	60.402	118.679	270 00 43
289	"	259	19.081	136.844	270 02 38
291	"	260	75.925	135.407	270 05 02
293	"	262	51.333	128.702	270 02 29
295	"	264	20.035	150.046	270 00 05
297	"	266	10.081	123.866	270 03 17
299	"	267	53.947	91.369	270 01 26
301	"	268	65.316	143.956	270 03 01
303	"	270	49.272	94.903	270 00 20
305	"	271	64.175	97.006	269 58 33
307	"	273	01.180	116.926	269 56 44
309	"	274	38.106	115.472	270 01 01
311	"	275	73.578	103.428	270 01 28
313	"	277	17.006	113.816	269 59 32
315	"	278	50.822	138.434	269 57 24
317	"	280	29.256	102.492	269 59 39
319	"	281	51.747	126.403	270 02 00
321	"	283	18.150	109.744	269 59 38
323	"	284	47.894	72.255	269 57 34

TABLE II—SUMMARY OF MONUMENT DATA—(concluded)

MONUMENT		DISTANCE		Azimuth To Forward Monument ° ' "	Elevation feet Above M.S.L. (Top of Post)
No.	Type	From Terminal Miles	East Chains	To Forward Monument Chains	
325	P.Pit.M.	285	40.149	115.644	269 56 13 2032.44
327	"	286	75.793	134.537	270 02 39 2085.66
329	"	288	50.330	137.618	270 00 38 2053.16
331	"	290	27.948	103.282	269 58 04 2024.57
333	"	291	51.230	272.991	270 01 18 1900.07
335	"	295	04.221	119.393	270 00 07 1886.76
337	"	296	43.614	160.788	269 57 53 1929.87
339	"	298	44.402	136.383	269 58 49 1956.71
341	"	300	20.785	96.658	269 58 37 1955.90
343	"	301	37.443	132.111	270 09 59 1981.20
345	"	303	09.554	116.291	270 07 30 2014.08
347	"	304	45.844	126.677	270 05 20 2034.78
349	"	306	12.521	110.946	270 02 57 2026.16
351	"	307	43.467	141.932	270 09 59 2025.33
353	"	309	25.399	175.050	270 07 19 2021.59
355	"	311	40.449	376.126	270 09 04 2009.57
357	"	316	16.574	102.069	270 06 06 1982.72
359	"	317	38.643	145.299	270 04 11 2031.89
361	"	319	23.942	53.291	270 04 34 1982.86
363	"	319	77.233	234.600	270 08 03 1975.81
365	"	322	71.833	67.730	270 03 40 1936.82
367	"	323	59.563	69.244	270 08 46 1937.65
369	"	324	48.807	146.078	270 07 28 1951.90
371	"	326	34.884	118.721	270 04 44 1946.52
373	"	327	73.605	125.881	270 02 31 1887.86
375	"	329	39.486	107.414	270 07 02 1854.87
377	"	330	66.900	137.144	270 07 15 1852.08
379	"	332	44.044	120.324	270 04 41 1844.14
381	"	334	04.368	130.701	270 02 25 1790.01
383	"	335	55.068	141.749	270 08 00 1727.21
385	"	337	36.817	109.353	270 06 25 1681.87
387	"	338	66.170	143.862	270 04 22 1641.82
389	"	340	50.032	81.101	270 01 41 1596.08
391	"	341	51.133	84.197	270 05 38 1574.65
393	"	342	55.330	124.648	270 06 34 1550.28
395	"	344	19.978	159.737	270 04 14 1500.26
397	"	346	19.716	26.106	270 02 32 1534.81
127-1	P.T.M.	346	45.822		1543.79

Monument 127-1 marks the northeast corner of British Columbia.

Abbreviations: P.S.M., standard post and stone mound; P.Pit.M., standard post, 4 pits, earth mound; P.Rock Pit.M., short standard post cemented in rock, 4 pits, earth mound; P., standard post; P.2 Pits M., standard post, 2 pits, earth mound; P.T.M., standard post, trench, mound; M.S.L., mean sea level.

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